

Novel Jamming-Resistant GPS Alternative - Comprehensive Electromagnetic Ambiance Mapping for Near-GPS Positioning Accuracy Under Conditions of Jamming as Tertiary Backup System

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Introduction

Efforts to secure even the latest generation of GPS satellites against jamming will inevitably be met with countermeasures that render those systems vulnerable in ways that may not have been anticipated by "GPS 3.0" designers. Given this, as well as the vulnerability of space-based platforms to "tagging" using robotic drone spacecraft, current navigation systems should be augmented with a tertiary system which, like inertial navigation, is not dependent upon space-based platforms for positional fixes.

Abstract

One such system already in use is inertial navigation, which has been substantially improved over the past five years. By coupling improved inertial navigation with a third guidance system: Comprehensive Electromagnetic Ambiance Mapping (CEAM,) inertial navigation systems may be relied upon for precision navigation and weapons guidance in the absence of reliable GPS reference.

Military and civilian radio traffic, regardless of nation, utilizes an entirely discrete set of frequencies from one another by design. One implication of this reality is that when military jamming is employed by a nation; particularly in their own territory; only military frequencies are jammed. A nation facing the possibility of their own civilian radio broadcasts being jammed by an outsider is unlikely to further muddy the waters by jamming their own civilian radio traffic. The limited availability of spectrum precludes the possibility of a developed nation re-shuffling the frequencies used for cellular communication, for instance. Existing civilian telecommunications devices are optimized for performance at a limited range of frequencies. Many of these devices cannot be re-programmed to operate on alternative frequencies through "over the air" updates. In the few cases where backup frequencies are pre-programmed into devices, those frequencies are not closely guarded secrets.

Given this and given the ubiquity of both civilian cellular communications (cell towers) and various other wireless communication devices with predictable usage patterns (which conform reliably to population density maps as well as traffic density maps i.e. many drivers using many cell phones in highway corridors creates unique patterns of high signal density coming from those corridors,) it should be possible for an aircraft or missile system to guess at its position by monitoring for this sort of radio traffic and using it as a reference

point, much as star-tracking systems in ICBMs use starlight. Just as star-tracking systems can account for the changing position of stars relative to the rotational position of the Earth as well as the seasonal wobble of the Earth on its own axis (using a simple clock and calendar,) the CEAM system would account for differing traffic patterns at differing times of day. Much of this data has already been inadvertently collected by commercial entities, namely Google as well as the "Big Three" American telecommunications companies. The fact that the U.S. is deliberately performing signal triangulation using cellular infrastructure means that it may be in possession of information which could, if somehow obtained by an enemy, be used to program exactly such a guidance system.

Maps of ambient patterns of electromagnetism in civilian bands can also be created via existing space-based ELINT platforms, assuming, of course, that this hasn't already been done. This baseline data would be programmed into such a tertiary navigation system so as to enable it to know its position relative to known EM ambiance patterns.

This system would have as an advantage that it would pay attention only to civilian-associated reference points such as those frequencies associated with cellular communications and commercial FM radio stations but would ignore signals on military frequencies on which there could be expected to be exceptional interference in a combat scenario.

Not only would such a system offer a tertiary backup in the event that inertial navigation's guidance data is insufficient for an application, it would be more accurate than inertial navigation under the condition that high-confidence positional fixes become impossible in the event of the destruction of the entire GPS constellation. Inertial navigation's perceived high accuracy is partly based upon a presumption that, at minimum, periodic GPS functionality can be used to correct for any drift. In the event of a war with an adversary with comparable or greater military capabilities, it ought to be anticipated that even intermittent GPS fixes would be available in only the rosier of war scenarios.

Conclusion

For all of the aforementioned reasons, it would be prudent to create a tertiary navigation system which employs as reference points known patterns of civilian radio usage in order to estimate geospatial position with a high degree of accuracy. On-board computer systems are now sufficiently powerful so as to enable the extrapolation of the geospatial position of an aircraft or missile given the large number of available signals emanating from known residential, commercial and transit-related clusters.

Although World War II saw the U.S. Government's order for residents to turn off the lights within their homes (so as to deny enemy bombers an opportunity to visually identify venues such as New York City from the sky,) it is unlikely that any government would take the measure of deliberately taking cellular service

offline so as to deny an adversary the opportunity to make use of CEAM-based guidance. This fact, as well as an abundance of existing data concerning up-to-date, time-resolved patterns of population (and therefore radio source) density recommends CEAM as the most reasonable tertiary navigation system to support aircraft and missile systems in wartime.